Determination of Critical Parameters by Processed Digital Images-Reliability Assessment by the Determinations for CO_2 and Isobutane

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Determination of the critical temperature and density by visual observation of the phase boundary of a sample fluid with naked eyes cannot avoid the personal uncertainty of the observer. Precise determination would be possible using digital images, because the sensitivity of digital images is higher than that of naked eyes. Development of an alternative determination method using signal-processing of observed digital images around the phase boundary of a sample fluid near the critical point was begun in 2005. The reliability of thermodynamic property measurements for carbon dioxide would be one of the best results among various fluids. In order to confirm the reliability of the determination by the proposed method, we measured and determined the critical density of carbon dioxide. Because a metastable state does not exist only at the critical point, we measured and determined the critical parameters by two means of measurement, by observing the meniscus appearance and disappearance with decreasing and increasing temperature at the critical density. Using this method, the preliminary critical temperature and density value of carbon dioxide are determined as being 304.139 K ± 0.010 K and 466.6 kg・m^{-3} ± 1.1 kg・m^{-3}, respectively. The reliability of the new method was confirmed by assessing and comparing with the best data for carbon dioxide. The critical temperature and density of isobutane were also determined using the same method. The preliminary critical temperature and density values of isobutane are determined as being 407.808 K ± 0.009 K and 223.0 kg・m^{-3} ± 1.1 kg・m^{-3}, respectively. Those critical parameters were determined as of November 2011. Additional confirmation will be planned to get final determinations. The critical pressure for those fluids will be also proposed on the basis of final critical temperature values with existing vapor-pressure data near the critical point.